



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04Q 7/22, H04B 7/005, H04Q 7/38		A2	(11) International Publication Number: WO 95/31879 (43) International Publication Date: 23 November 1995 (23.11.95)
(21) International Application Number: PCT/FI95/00249 (22) International Filing Date: 10 May 1995 (10.05.95)		(81) Designated States: AU, CN, DE, GB, JP, NO, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(30) Priority Data: 942191 11 May 1994 (11.05.94) FI		Published <i>In English translation (filed in Finnish). Without international search report and to be republished upon receipt of that report.</i>	
(71) Applicants (for all designated States except US): NOKIA TELECOMMUNICATIONS OY [FI/FI]; Makkylän puistotie 1, FIN-02600 Espoo (FI). NOKIA MOBILE PHONES LTD. [FI/FI]; Nakolantie 8, FIN-24100 Salo (FI).			
(72) Inventors; and (75) Inventors/Applicants (for US only): HONKASALO, Zhi-Chun [GB/FI]; Melkonkatu 8 B 29, FIN-00210 Helsinki (FI). HONKASALO, Harri [FI/FI]; Melkonkatu 8 B 29, FIN-00210 Helsinki (FI). JOKINEN, Harri [FI/FI]; Vähähiidentie 250, FIN-25390 Hiisi (FI). POSTI, Harri [FI/FI]; Melojantie 1 A 9, FIN-90560 Oulu (FI).			
(74) Agent: OY KOLSTER AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).			
(54) Title: CONTROL OF HANDOVER AND TRANSMISSION POWER CONTROL OF MOBILE STATION IN A MOBILE TELECOMMUNICATIONS SYSTEM			
(57) Abstract <p>The invention relates to methods and an arrangement for controlling transmitting power of a mobile station (MS) and carrying out a handover in a mobile telecommunications system in which data is transmitted over the radio path between a mobile station and a base station (BTS) as bursts in time slots of successive frames. A mobile station can be allocated at least two time slots in each frame for high-speed data transmission. The mobile station is arranged to measure the characteristics of the received signal, such as the signal level and/or quality, in each time slot allocated to the mobile station, and that the fixed radio network is arranged to control the transmitting power of the mobile station and/or make the decision on a handover on the basis of a combination of measurement results of two or more time slots, or on the basis of the measurement result of the poorest time slot.</p>			
BEST AVAILABLE COPY			

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

Control of handover and transmission power control of
mobile station in a mobile telecommunications system

5 The present invention relates to methods and an
arrangement for power control of a mobile station, and
performing a handover in a mobile telecommunications
system in which data is transmitted over the radio path
between a mobile station and a base station of a fixed
radio network as bursts in time slots of successive
10 frames.

10 **Background of the Invention**

15 In mobile telecommunications systems of the time
division multiple access (TDMA) type, time division
communication in the radio path takes place in
successive TDMA frames each of which consists of several
time slots. In each time slot, a short information
packet is sent as a radio frequency burst of a finite
duration, which burst consists of a number of modulated
bits. For the most part, time slots are used for the
20 transmission of control channels and traffic channels.
On the traffic channels, speech and data are
transmitted. On the control channels, signalling between
a base station and mobile subscriber stations is carried
out. The Pan-European mobile system GSM (Global System
25 for Mobile Communications) is an example of a TDMA radio
system.

30 For communication in conventional TDMA systems,
each mobile station is assigned one time slot of traffic
channel for data or speech transmission. Thus, a GSM
system, for example, can have as much as eight
simultaneous connections to different mobile stations
on a same carrier frequency. The maximum data transfer
rate on a traffic channel is restricted to a relatively
low level according to the bandwidth in use as well as
35 channel coding and error correction, for example in a

5 GSM system to 9,6 kbit/s or 12 kbit/s. In addition, in a GSM system a half-speed traffic channel (max. 4,8 kbit/s) can be chosen for low speeds of speech coding. The half-speed traffic channel is established when a mobile station communicates in a specific time slot only in every second frame, in other words, in half-speed. A second mobile station communicates in every second frame in the same time slot. This is how the capacity of the system can be doubled as far as the number of 10 subscribers is concerned, in other words, on the same carrier wave it is possible for up to 16 mobile stations to communicate simultaneously.

15 In the last few years, the need for high-speed data services in mobile communication networks has remarkably increased. Data transfer rates of at least 64 kbit/s would be needed to utilize, for example, ISDN (Integrated Services Digital Network) circuit switched digital data services. PSTN data services of the public telephone network, such as modems and telefax terminals 20 of class G3, require faster transfer rates, such as 14,4 kbit/s. One of the growing areas of mobile data transfer requiring higher transfer rates is the mobile video service. As examples of this kind of services, security control by cameras and video databases can be mentioned. 25 The minimum data transfer rate in video transfer can be, for example, 16 or 32 kbit/s.

30 The data transfer rates of the present mobile communication networks are not, however, sufficient to satisfy this kind of new needs.

30 Summary of the Invention

It is an object of the present invention to enable higher data transfer rates in mobile communication networks.

Another object of the invention is a handover and power control of a mobile station in connection with high-speed data transmission.

5 This object is achieved by a method for power control of a mobile station in a mobile telecommunications system which method comprises transmitting data over the radio path between a mobile station and a base station of a fixed radio network as bursts in time slots of successive frames, and
10 allocating the mobile station at least two time slots in each frame for high-speed data transmission, which method comprises

15 measuring the characteristics of the received signal, such as signal level and/or quality, at the mobile station in each time slot allocated to the mobile station,

20 controlling the transmitting power of a mobile station on the basis of a combination of measurement results of two or more time slots, or on the basis of a measurement result of the poorest time slot.

25 The invention also relates to a handover method in a mobile telecommunications system which method comprises transmitting data over the radio path between a mobile station and a base station of a fixed radio network as bursts in time slots of successive frames, and allocating the mobile station at least two time slots in each frame for high-speed data transmission, which method comprises

30 measuring the characteristics of the received signal, such as signal level and/or quality, at the mobile station in each time slot allocated to the mobile station,

making a handover decision on the basis of a combination of measurement results of two or more time

slots, or on the basis of a measurement result of the poorest time slot.

The invention also relates to a control arrangement of a mobile station in a mobile telecommunications system in which data is transmitted over the radio path between a mobile station and a base station of a fixed radio network as bursts in time slots of successive frames, and a mobile station can be allocated at least two time slots in each frame for high-speed data transmission, which arrangement comprises that a mobile station is arranged to measure the characteristics of the received signal, such as signal level and/or quality, in each time slot allocated to the mobile station, and that the fixed radio network is arranged to control the transmitting power of a mobile station and/or make a handover decision on the basis of a combination of measurement results of two or more time slots, or on the basis of a measurement result of the poorest time slot.

The invention employs a so-called multi-slot technique so that a mobile station has access to two or more time slots in each frame. The high-speed data signal to be transmitted over the radio path is split into a required number of data signals of lower speed, each signal being transmitted as bursts in a respective time slot. As soon as the data signals of lower speed have separately been transmitted over the radio path, they are again at the receiving end combined into the original high-speed signal. This is how the data transfer rate can be doubled, tripled, etc., depending on whether two, three or more time slots are assigned to be used by a subscriber. In a GSM system, for example, two time slots will enable a data transfer speed of 2x9,6 kbit/s which is enough for a modem of 14,4 kbit/s, or a telefax terminal, for example. Six

time slots will enable a data transfer rate of 64 kbit/s.

5 The multi-slot technique in accordance with the invention, in which a high-speed data signal is transmitted as several bursts in several time slots within one frame, has many advantages over an alternative approach in which a mobile station is also assigned several time slots in the same frame for data transmission, but the whole data signal is transmitted as one burst extended for the time of the assigned time slots. In the present invention, there is no need to change the other significant characteristics of the physical transmission path (radio path, for example, Layer 1 of GSM), such as frequency division, frame format and time slot configuration, data transfer rate, error correction, modulation, format of a TDMA burst, bit error ratio (BER), etc. In other words, by the present invention it is possible to support different kind of subscriber data transfer rates in the radio system by a single structure of a physical transmission path. Consequently there is no need to support several structures of a physical transmission path by the subscriber terminals, either.

10

15

20

25 The multi-slot technique of the invention enables that each time slot, i.e. traffic channel, allocated to a mobile station can be handled as an independent traffic channel with regard to measurements, transmitting of measurement reports, and power control. Each traffic channel is measured independently. In the primary embodiment of the invention, it is possible to carry out the power control and the reporting of measurement results independently for each time slot by associating an individual, parallel control channel with each traffic channel time slot. This is advantageous, because the signal quality can vary considerably in

30

35

5 different time slots due to, for example, different interference conditions. By the splitted power control, a more optimal multi-slot system can be obtained with regard to power used and the quality of the received signal. An optimized use of transmitting power means a lower average transmitting power, which leads to a longer battery life. The average interference level in the system is also decreased resulting in a higher system capacity.

10 In a second embodiment of the invention, all the time slots have their own control channels through which measurement reports are transmitted, but power control is performed for each channel through only one single control channel in the direction from the fixed network 15 to a mobile station.

20 Similar kinds of improvements in the performance of the system, albeit of less importance, are obtained by using a common, parallel control channel for all time slots assigned to a mobile station so that a combination of measurement results of all the time slots, for example, average value, is transmitted to the fixed radio network over the common control channel. The fixed radio network controls the transmitting power of the 25 mobile station through the same common control channel.

30 The reliability of handover decisions can also be improved in a multi-slot system in cases every time slot assigned to a mobile station is independently measured in accordance with the invention, and the handover decision is made on the basis of a combination of the measurement results, such as average value, or on the 35 basis of the poorest time slot.

35 The implementation may be especially simple if adjacent time slots are employed. Consequently, it will be easier to carry out various measurements the remaining part of the frame, and increasing the number

of frequency synthesizers in the receiver of the mobile station is avoided. In the GSM system, it is especially advantageous to implement the invention by two time slots.

5 **Brief Description of the Drawings**

In the following, the invention will be described in greater detail by the primary embodiments with reference to the accompanying drawings in which

10 Figure 1 illustrates a section of a mobile system in which the invention can be applied, and

Figures 2, 3, 4 and 5 illustrate a TDMA frame format,

Figure 6 illustrates a TCH/F+SACCH multiframe,

15 Figure 7 illustrates a conventional data transmission in one time slot,

Figure 8 illustrates data transmission in accordance with the invention in two time slots,

20 Figure 9 illustrates the timing of transmission, reception and measurements in a data transmission of one time slot,

Figure 10 illustrates the timing of transmission, reception and measurements in a data transmission of two time slots.

The Preferred Embodiments of the Invention

25 The present invention can be applied to high-speed data transmission in most of the digital mobile systems of the TDMA type such as, for example, the Pan-European digital mobile system GSM, DSC1800 (Digital Communication System), UMTS (Universal Mobile Telecommunication System), FPLMTS (Future Public Land Mobile Telecommunication System), etc.

30 A mobile system of the GSM type is illustrated as an example. GSM (Global System for Mobile Communications) is a Pan-European mobile system. Figure 35 1 very briefly illustrates the basic elements of the GSM

system without going any further into the details or other sub-sections of the system. For a closer description of the GSM system, the GSM recommendations and "The GSM System for Mobile Communications", by M. Mouly & M. Pautet, Palaiseau, France, 1992, ISBN: 2-9507190-0-7 is referred to.

A mobile services switching centre MSC handles the connecting of incoming and outgoing calls. It performs functions similar to those of an exchange of a public telephone network (PSTN). In addition to these, it also performs functions characteristic of mobile communications only, such as subscriber location management in co-operation with the subscriber registers of the network. As subscriber registers, the GSM system at least includes the home location register HLR and the visitor location register VLR which are not shown in Figure 1. More accurate information of the location of the subscriber, usually the accuracy of the location area, is stored in the visitor location register, there being typically one VLR per each mobile services switching centre MSC, while the HLR knows which VLR area the mobile station MS is visiting. The mobile stations MS are connected to the centre MSC by base station systems. The base station system consists of a base station controller BSC and base stations BTS. One base station controller is used to control several base stations BTS. The tasks of the BSC include, among other things, handovers in cases in which the handover is performed within the base station, or between two base stations controlled by the same BSC. Figure 1 only shows, for reasons of clarity, a base station system in which nine base stations BTS1-BTS9 are connected to a base station controller BSC, the radio coverage area of which base stations forms the corresponding radio cells C1-C9.

5 The GSM system is a time division multiple access (TDMA) system in which the time division traffic on the radio path takes place in successive TDMA frames each of which consists of several time slots. In each time
10 slot, a short information packet is sent as a radio frequency burst of a finite duration, which burst consists of a number of modulated bits. For the most part, time slots are used for the transmission of control channels and traffic channels. On the traffic channels, speech and data are transmitted. On the control channels, signalling between a base station and mobile subscriber stations is carried out.

15 Channel structures used in radio interface of the GSM system are described in closer detail in the ETSI/GSM recommendation 05.02. The TDMA frame format of a the GSM system is illustrated as an example in Figures 2-5. Figure 5 illustrates a TDMA basic frame which includes eight time slots 0-7 used as traffic channels or control channels. Thus, only one radio frequency burst shorter than the duration of the time slot is transmitted in each time slot. As soon as one TDMA basic frame ends in time slot 7, the time slot 0 of the next basic frame immediately begins. Thus, 26 or 51 successive TDMA frames form a multiframe depending on whether a traffic channel or a control channel structure is in question, as illustrated in Figure 4. A superframe consists of 51 or 26 successive multiframe depending on whether the multiframe have 26 or 51 frames, as illustrated in Figure 3. A hyperframe is formed of 2048 superframes, as illustrated in Figure 2. The hyperframe is the biggest successive frame unit whose ending starts a new, similar hyperframe.

30 Figure 6 illustrates a structure of a full-speed traffic channel TCH/F-SACCH/TF defined by the recommendation, in which structure a multiframe includes
35

24 full-speed traffic channel frames TCH, one parallel control channel frame SACCH and a dummy frame IDLE. In each time slot assigned to be used as traffic channels, the control channel SACCH and a dummy time slot are repeated every 26 time slots. The positions of the frames SACCH and IDLE are different for time slots 0, 2, 4 and 6 than for time slots 1, 3, 5, and 7. What is illustrated in Figure 7 is valid for time slots 0, 2, 4 and 6. In time slots 1, 3, 5 and 7, frames IDLE and SACCH exchange places. The control channel SACCH is used for reporting the measurement results from the mobile station to the fixed radio network, and for controlling of the mobile station, for example, power adjustment, from the fixed radio network.

In normal operation, at the beginning of a call a mobile station MS is assigned one time slot from a carrier wave as a traffic channel (single slot access). The mobile station MS synchronizes into this time slot to transmit and receive radio frequency bursts. In Figure 7, for example, a mobile station MS is locked to the time slot 0 of a frame. Channel coding, interleaving, burst formation, and modulation 70 are carried out to the data to be transmitted DATAIN, after which operations the radio frequency burst is transmitted in the time slot 0 of each TDMA frame. In the remaining part of the frame, the MS carries out various kinds of measurements, as will be described below.

In accordance with the invention, a mobile station MS requiring data transmission of higher speed than one traffic channel can offer, is assigned two or more time slots from the same frame.

The multi-slot technique according to the invention requires certain additional features in the signalling in connection with traffic channel

allocation. During the call set-up time, assigning a traffic channel to a mobile station is carried out by an assignment command which is transmitted to the mobile station by the fixed network. This message must contain the data of all the traffic channels that are assigned to a mobile station MS for high-speed data transmission according to the invention. Already by now, the GSM system must be able to address two half-speed traffic channels in the same assignment command, which is why the message contains descriptions and modes for both the first as well as the second traffic channel. The present assignment command can easily be expanded to cover the addressing of at least two time slots, i.e. full-speed traffic channels. An assignment command is described in the GSM recommendation 04.08, version 4.5.0, June 1993, pp. 168-170. Channel addressing in accordance with the invention can be performed in the assignment command data elements Mode of first channel, mode of second channel, and Channel Description Information element, which are described in greater detail in the GSM recommendation 04.08, version 4.5.0, June 1993, pp. 316-350. For addressing more than two time slots, a new message must be determined. Due to the fact that all the channels addressed are of the same type of channel, TCH/F, the message can be limited to describe the type of the first channel and then the total number of channels required. In such a case, the message would be rather short and simple.

Correspondingly, in case of a handover, the handover command must be able to address two or more time slots in the same frame. In the GSM system, the handover command contains the same data fields as described above in connection with the assignment command, and thus it can be applied to the requirements of the invention with similar changes. The handover

command is described in the GSM recommendation 04.08, version 4.5.0, June 1993, pp. 184-189.

A second alternative is to employ a dedicated assignment command for each time slot

5 In both cases, both outgoing and incoming call set-up messages (SETUP) of a mobile station must contain information about the actual channel requirements, in other words, the number of time slots needed. This information may be included in the Bearer Capability
10 Information element BCIE. The BCIE is described in the GSM recommendation 04.08, version 4.5.0, pp. 423-431.

15 Figure 8 shows an example in which a mobile station MS is assigned successive time slots 0 and 1 from the same TDMA frame. A high-speed data signal DATAIN to be transferred over the radio path is split in the divider 82 into a necessary number of data signals of lower speed DATA1 and DATA2. Channel coding, interleaving, burst formation and modulation 80, and, correspondingly, 81, are separately carried out to each
20 data signal of lower speed DATA1 and DATA2, after which each data signal is transmitted as a radio frequency burst in its dedicated time slot 0 and 1, respectively. As soon as the lower speed data signals DATA1 and DATA2 are separately transmitted over the radio path, demodulation, deinterleaving and channel decoding 83 and, correspondingly, 84, of the signals are separately performed at the receiving end, after which the signals DATA1 and DATA2 are combined into the original high-speed signal DATAOUT in the combiner 85 at the receiving
25 end.

30

35 On the fixed network side, the functions of blocks 80, 81, 83, 84 of Figure 8, in other words, channel coding, interleaving, burst formation and modulation, and, correspondingly, demodulation, deinterleaving and channel decoding are located advantageously at the base

station BTS. The base station BTS has a separate, parallel handling for each time slot. The divider 82 and the combiner 85 can, in turn, be assigned, as needed, to any network element such as a base station BTS, a base station controller BSC, or a mobile services switching centre MSC. In cases the divider 82 and the combiner 85 are located in another network element than the base station BTS, the data signals of lower speed DATA1 and DATA2 are transmitted between that element and the base station BTS similarly to signals on normal traffic channels.

In a fixed network of the GSM system, various functions relating to speech coding and rate adaptation are concentrated in a TRCU (Transcoder/Rate Adaptor Unit). The TRCU may be located in several alternative places in the system according to choices made by the manufacturer. Typically, the TRCU is placed at the mobile services switching centre MSC, but it may also be a part of a base station controller BSC or a base station BTS. In cases the TRCU is placed apart from a base station BTS, information is transmitted between the base station and the transcoder/rate adaptor unit TRCU in so-called TRAU frames. The function of the transcoder/rate adaptor unit is defined in the GSM recommendation 08.60. A combiner 85 and a divider 83 in accordance with the invention may be placed with this transcoder/rate adaptor unit TRCU.

In a mobile station MS, the blocks 80, 81, 83 and 84 of Figure 8, in other words, channel coding, interleaving, burst formation and modulation, and, correspondingly, demodulation, deinterleaving and channel decoding, are advantageously implemented by a processing unit common to all time slots, at least in an embodiment of two time slots.

As is well known, mobile stations MS can freely roam in the area of a mobile system from one cell to another. If a mobile station is not handling a call, switching from one cell to another is simply a registration to a new cell. If a mobile station MS is handling a call during the switching of cells, the call must also be switched from one base station to another by a way which causes as little disturbance to the call as possible. Switching cells during a call is called a handover. A handover can also be carried out within a cell from one traffic channel to another.

If a mobile station MS roams in a radio network, a handover from the serving cell to a neighbouring cell is normally performed either (1) as the measurement results of the mobile station MS and/or the base station BTS indicate a low signal level and/or quality from the current serving cell and a better signal level can be obtained from a neighbouring cell, or (2) as a neighbouring cell enables communication at lower transmitting power levels, in other words, as the mobile station MS is in a border area between cells. In radio networks, the aim is to avoid unnecessarily high power levels and thus interference elsewhere in the network.

In Figure 9, a mobile station is in a normal manner locked into a time slot 0 of a frame. In the time slot 0, the traffic channel TCH assigned to the mobile station is transmitted. In addition, in every 26th frame of the same time slot a parallel control channel SACCH is transmitted, as described in connection with Figure 6. According to the GSM recommendations, a mobile station MS monitors (measures) the level and quality of the downlink signal of the serving cell in time slot 0 on the traffic channel TCH assigned to it. During the other time slots, the mobile station MS measures the levels of the downlink signals of the neighbouring cells

5 of the serving cell. All the measurement results of the mobile station MS are regularly transmitted to a base station controller BSC through a parallel control channel SACCH associated with the time slot of traffic channel TCH. The base station BTS monitors (measures) the level and quality of the uplink signal received from each of the mobile stations MS served by said base station BTS.

10 On the basis of the measurement results, the BSC controls the power of the mobile station MS by power control commands transmitted to the MS in the downlink direction through the control channel SACCH, and makes the handover decisions.

15 Procedures and calculations used in radio networks for determining suitable transmitting power levels are referred to as power control algorithms. There are many different types of algorithms, but usually their aim is the lowest possible transmitting power level and, thus, low interference levels.

20 Decisions on handovers during on-going calls are made by a base station controller BSC on the basis of various handover parameters assigned to each cell, and on the basis of measurement results reported by a mobile station MS and base stations BTS. A handover is normally carried out on the basis of criteria of the radio path, but it can be performed due to other reasons as well, for example, load sharing. The procedures and calculations used as the basis of a handover decision are referred to as a handover algorithm. Alternatively, 25 all handover decisions can be made at a mobile services switching centre MSC to which all the measurement results are in such a case transmitted. A MSC also controls at least those handovers occurring from the area of one base station controller to the area of another.

As a mobile station is, in accordance with the invention, assigned several time slots within the same frame for high-speed data transmission, the mobile station measures the level and quality of the downlink signal separately in each time slot assigned to it. In the example of Figure 10, a mobile station is assigned the adjacent time slots 0 and 1. The mobile station MS measures the level and quality of the downlink signal of the serving cell independently in time slot 0 and 1 on the traffic channel TCH assigned to it. During the other time slots, the mobile station MS measures the levels of the downlink signals of the neighbouring cells of the serving cell.

In the primary embodiment of the present invention, each time slot assigned to a mobile station MS, the traffic channel TCH, has a dedicated parallel control channel SACCH through which the measurement results relating to the respective time slot are transmitted to a base station controller BSC.

A base station controller BSC controls the transmitting power of a mobile station MS separately in each time slot, in other words, on the traffic channel TCH, by power control commands transmitted to the mobile station MS in the downlink direction through the control channel SACCH of the traffic channel. Power control on an individual channel is otherwise carried out in accordance with the GSM recommendations.

Alternatively, a base station controller BSC may control the transmitting power levels of all the time slots by a common power control command transmitted to the mobile station MS in the downlink direction through one of the parallel control channels.

The handover decision is made by the base station controller on the basis of a combination of measurement results of two or more time slots assigned to a mobile

station, or on the basis of a measurement result of the poorest time slot. As the decision to carry out a handover is made, a modified handover command is transmitted to the mobile station MS, as described above.

5 In a second embodiment of the present invention, all the time slots assigned to a mobile station MS, the traffic channels TCH, have a common, parallel control channel SACCH through which a combination of measurement results of the time slots is transmitted to a base station controller BSC. This combination of the measurement results can, for example, be the average value of the measurement results of the various time slots.

10 15 The base station controller BSC controls the transmitting power levels of the mobile station MS jointly in all the time slots, in other words, on the traffic channels TCH, by common power control commands transmitted to the mobile station MS in the downlink direction through the common control channel SACCH.

20 25 The handover decision is made by the base station controller on the basis of a combination of measurement results of either all or some of the time slots assigned to a mobile station MS. As the decision to carry out a handover is made, a modified handover command is transmitted to the mobile station as described above.

25 30 The Figures and the description referring to them are only intended to illustrate the present invention. The method and arrangement of the invention may vary in details within the scope of the attached claims.

Claims

1. A method for power control of a mobile station in a mobile telecommunications system which method comprises transmitting data over the radio path between a mobile station and a base station of a fixed radio network as bursts in time slots of successive frames, and allocating the mobile station at least two time slots in each frame for high-speed data transmission,
5 characterized by
measuring the characteristics of the received signal, such as signal level and/or quality, at the mobile station in each time slot allocated to the mobile station,
- 10 15 characterized by
controlling the transmitting power of a mobile station on the basis of a combination of measurement results of two or more time slots, or on the basis of a measurement result of the poorest time slot.
- 20 25 30 35 2. A method as claimed in claim 1, characterized by
assigning a mobile station a parallel control channel common to all the time slots assigned to the mobile station,
transmitting a combination of measurement results of all the time slots from the mobile station to a fixed radio network through said common, parallel control channel,
controlling the transmitting power of the mobile station in all the time slots through said common, parallel control channel.
3. A method as claimed in claim 1, characterized by
assigning a mobile station a dedicated parallel control channel for each time slot assigned to the mobile station,

transmitting the measurement results of each time slot separately from the mobile station to a fixed radio network through the parallel control channel corresponding to said time slot,

5 controlling the transmitting power of the mobile station in each time slot through the control channel corresponding to said time slot.

4. A method as claimed in claim 1, characterized by

10 assigning a mobile station a dedicated parallel control channel for each time slot assigned to the mobile station,

transmitting the measurement results of each time slot separately from the mobile station to a fixed radio network through the parallel control channel corresponding to said time slot,

15 controlling the transmitting power of the mobile station in all the time slots through one common, parallel control channel.

20 5. A handover method in a mobile telecommunications system which method comprises transmitting data over the radio path between a mobile station and a base station of a fixed radio network as bursts in time slots of successive frames, and allocating the mobile station at least two time slots in each frame for high-speed data transmission, characterized by

25 measuring the characteristics of the received signal, such as signal level and/or quality, at the mobile station in each time slot allocated to the mobile station,

30 making a handover decision on the basis of a combination of measurement results of two or more time slots, or on the basis of a measurement result of the poorest time slot.

6. A method as claimed in claim 5, characterized by

5 assigning a mobile station a parallel control channel common to all the time slots assigned to the mobile station,

transmitting a combination of measurement results of all the time slots from the mobile station to the fixed radio network through said common, parallel control channel.

10 7. A method as claimed in claim 5, characterized by

assigning a mobile station a dedicated parallel control channel for each time slot assigned to the mobile station,

15 transmitting the measurement results of each time slot separately from the mobile station to a fixed radio network through the parallel control channel corresponding to said time slot.

20 8. A control arrangement of a mobile station in a mobile telecommunications system in which data is transmitted over the radio path between a mobile station and a base station of a fixed radio network as bursts in time slots of successive frames, and a mobile station can be allocated at least two time slots in each frame for high-speed data transmission, characterized in that a mobile station is arranged to measure the characteristics of the received signal, such as signal level and/or quality, in each time slot allocated to the mobile station, and that the fixed radio network 25 is arranged to control the transmitting power of a mobile station and/or make a handover decision on the basis of a combination of measurement results of two or more time slots, or on the basis of a measurement result of the poorest time slot.

9. An arrangement as claimed in claim 8, characterized in that a mobile station has a parallel control channel common to all the time slots assigned to the mobile station, and that the mobile station is arranged to transmit a combination of measurement results of all the time slots from the mobile station to a fixed radio network through said common, parallel control channel.

10 10. An arrangement as claimed in claim 9, characterized in that the fixed radio network is arranged to control the transmitting power of the mobile station in all the time slots through said common, parallel control channel.

15 11. An arrangement as claimed in claim 8, characterized in that a mobile station has a dedicated, parallel control channel for each of the time slots assigned to the mobile station, and that the mobile station is arranged to separately transmit a combination of measurement results of all the time slots to a fixed radio network through the parallel control channel corresponding to said time slot.

20 25 12. An arrangement as claimed in claim 11, characterized in that a fixed network is arranged to control the transmitting power of a mobile station in each time slot through the parallel control channel corresponding to said time slot.

30 13. An arrangement as claimed in claim 11, characterized in that a fixed network is arranged to control the transmitting power of a mobile station in all the time slots through one parallel control channel.

1/4

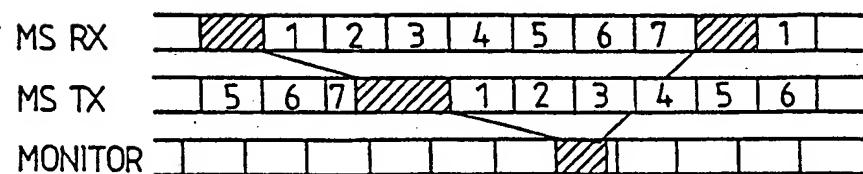
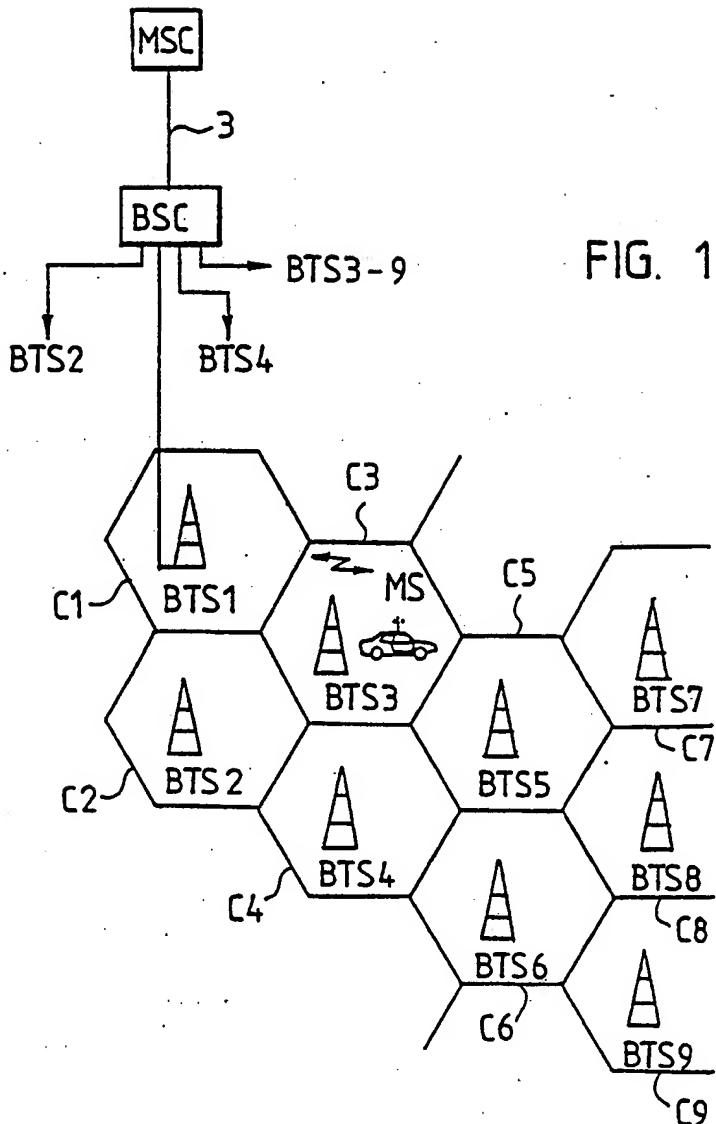


FIG. 9

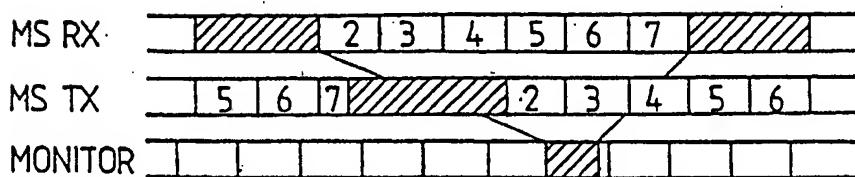
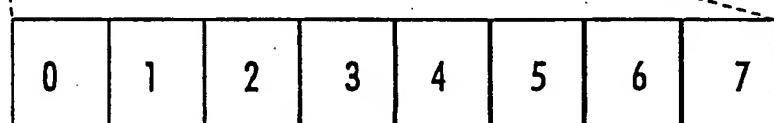
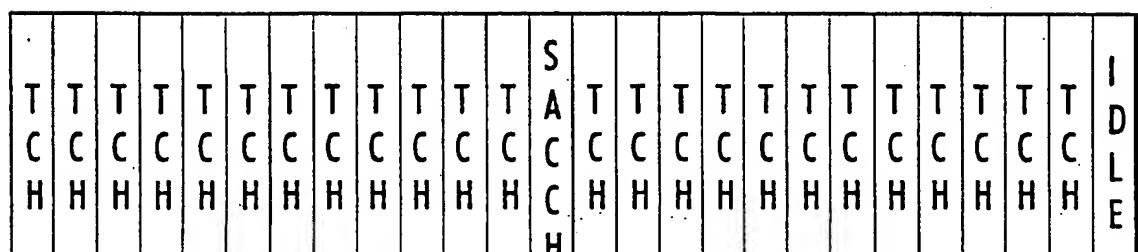


FIG. 10

2/4

**FIG. 2****FIG. 3****FIG. 4****FIG. 5**

TCH/F - MULTIFRAME

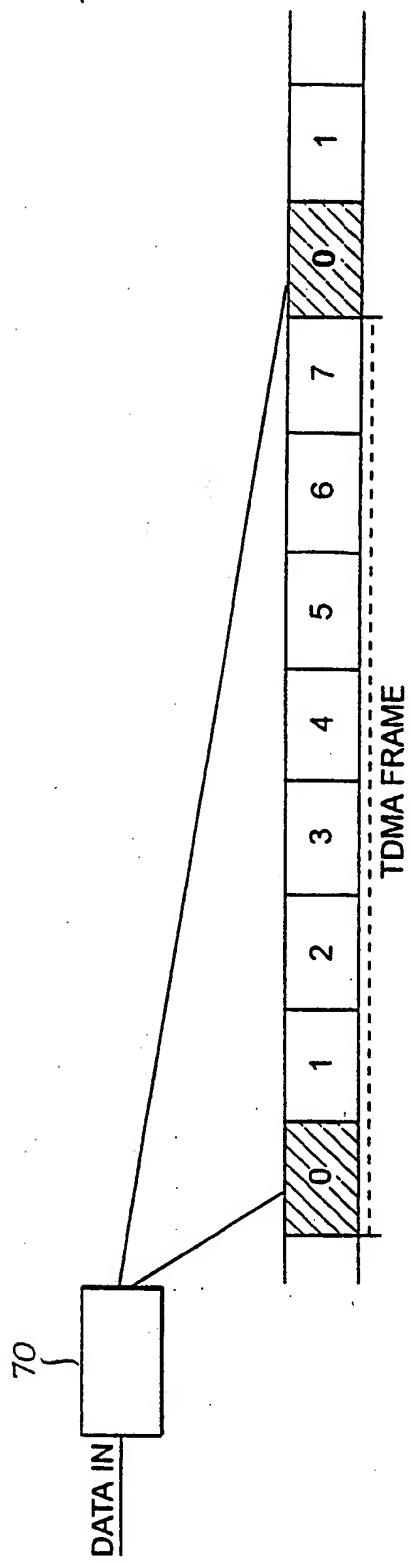


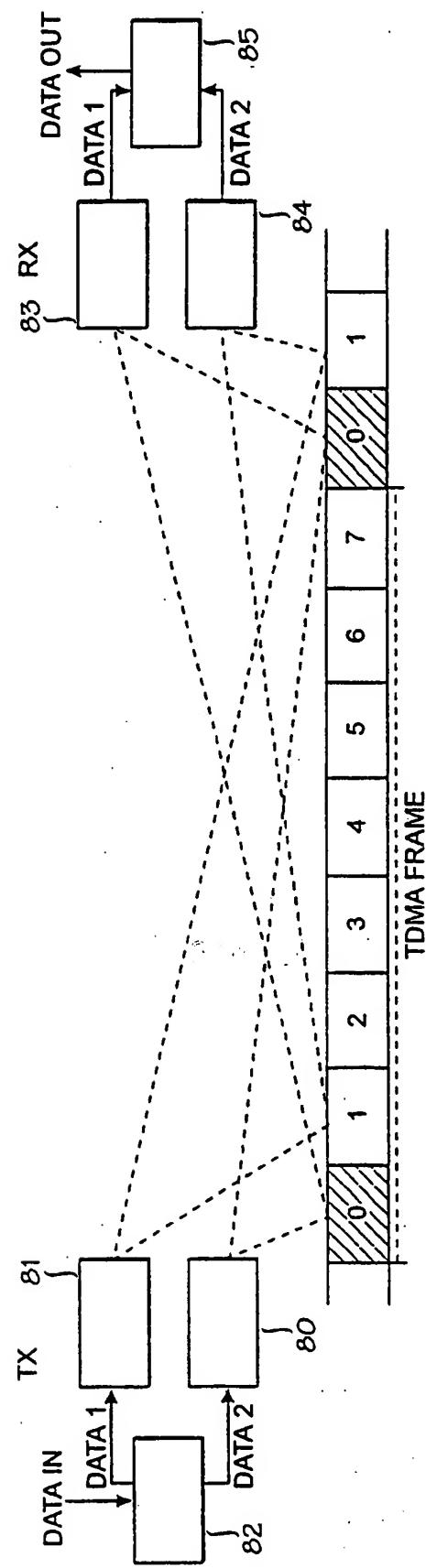
0...

...25

FIG. 6

3/4

**FIG. 7**

**FIG. 8**

THIS PAGE BLANK (USPTO)



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04B 7/005, H04Q 7/22, 7/38		A3	(11) International Publication Number: WO 95/31879 (43) International Publication Date: 23 November 1995 (23.11.95)
<p>(21) International Application Number: PCT/FI95/00249</p> <p>(22) International Filing Date: 10 May 1995 (10.05.95)</p> <p>(30) Priority Data: 942191 11 May 1994 (11.05.94) FI</p> <p>(71) Applicants (for all designated States except US): NOKIA TELECOMMUNICATIONS OY [FI/FI]; Makkylän puistotie 1, FIN-02600 Espoo (FI). NOKIA MOBILE PHONES LTD. [FI/FI]; Nakolantie 8, FIN-24100 Salo (FI).</p> <p>(72) Inventors; and</p> <p>(75) Inventors/Applicants (for US only): HONKASALO, Zhi-Chun [GB/FI]; Melkonkatu 8 B 29, FIN-00210 Helsinki (FI). HONKASALO, Harri [FI/FI]; Melkonkatu 8 B 29, FIN-00210 Helsinki (FI). JOKINEN, Harri [FI/FI]; Vähähiidentie 250, FIN-25390 Hiisi (FI). POSTI, Harri [FI/FI]; Melojantie 1 A 9, FIN-90560 Oulu (FI).</p> <p>(74) Agent: OY KOLSTER AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).</p>		<p>(81) Designated States: AU, CN, DE, GB, JP, NO, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments. In English translation (filed in Finnish).</p> <p>(88) Date of publication of the international search report: 7 December 1995 (07.12.95)</p>	
<p>(54) Title: CONTROL OF HANDOVER AND TRANSMISSION POWER CONTROL OF MOBILE STATION IN A MOBILE TELECOMMUNICATIONS SYSTEM</p> <p>(57) Abstract</p> <p>The invention relates to methods and an arrangement for controlling transmitting power of a mobile station (MS) and carrying out a handover in a mobile telecommunications system in which data is transmitted over the radio path between a mobile station and a base station (BTS) as bursts in time slots of successive frames. A mobile station can be allocated at least two time slots in each frame for high-speed data transmission. The mobile station is arranged to measure the characteristics of the received signal, such as the signal level and/or quality, in each time slot allocated to the mobile station, and that the fixed radio network is arranged to control the transmitting power of the mobile station and/or make the decision on a handover on the basis of a combination of measurement results of two or more time slots, or on the basis of the measurement result of the poorest time slot.</p>			

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Larvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 95/00249

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04B 7/005, H04Q 7/22, H04Q 7/38
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04B, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0332818 A2 (MOTOROLA, INC.), 20 Sept 1989 (20.09.89), column 8, line 42 - line 54; column 12, line 31 - column 13, line 3, abstract --	1-13
P, A	EP 0615353 A1 (ALCATEL RADIOTELEPHONE), 14 Sept 1994 (14.09.94), abstract --	1-13
A	ETSI TDOC smal 238/93 PACKET DATA OVER GSM NETWORK 28.09.1993 Jari Hämäläinen et al -- -----	1-13

 Further documents are listed in the continuation of Box C. See patent family annex.

- * Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

9 November 1995

Date of mailing of the international search report

09 - 11 - 1995

Name and mailing address of the ISA/
 Swedish Patent Office
 Box 5055, S-102 42 STOCKHOLM
 Facsimile No. + 46 8 666 02 86

Authorized officer

Elisabet Åselius
 Telephone No. + 46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/10/95

International application No.
PCT/FI 95/00249

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0332818	20/09/89	JP-A- 1274524 US-A- 4887265	02/11/89 12/12/89
EP-A1- 0615353	14/09/94	NONE	

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- BLACK BORDERS**
- IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- FADED TEXT OR DRAWING**
- BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- SKEWED/SLANTED IMAGES**
- COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- GRAY SCALE DOCUMENTS**
- LINES OR MARKS ON ORIGINAL DOCUMENT**
- REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

THIS PAGE BLANK (USPTO)